

CLAIMS

- 1 1. A self-starting reference circuit for providing a reference electrical characteristic  
2 comprising:  
3 a current mirror including a first p-channel field effect transistor (FET) and a second p-  
4 channel FET configured to supply a reference current across the first FET and a mirrored output  
5 current across the second FET, each p-channel FET having a gate, a source and a drain wherein  
6 the gates of these FETs are connected, the sources are connected to a power supply, and the drain  
7 of the second FET is connected to the gates of these FETs; and  
8 a current source including a first n-channel FET which is a low-threshold n-channel FET  
9 having a source, a gate and a drain, the gate of the low-threshold FET having a gate threshold  
10 voltage and being connected to the drain of the first p-channel FET and the drain of the low-  
11 threshold n-channel FET being connected to the drain of the second p-channel FET, the current  
12 source further including a reference regulator circuit for receiving the reference current from the  
13 drain of the first p-channel transistor and a reference output circuit for receiving the mirrored  
14 output current flowing from the source of the first low-threshold n-channel FET and outputting a  
15 reference electrical characteristic.
- 1 2. The self-starting reference circuit of claim 1 wherein the gate threshold voltage is about zero  
2 volts.
- 1 3. The self-starting reference circuit of claim 1 wherein the gate threshold voltage is slightly  
2 negative.
- 1 4. The self-starting reference circuit of claim 1 wherein the circuit is implemented in  
2 complementary metal-oxide semiconductor (CMOS).

1 5. The self-starting reference circuit of claim 1 wherein the circuit is implemented in analog  
2 CMOS.

1 6. The self-starting reference circuit of claim 1 wherein the low-threshold FET lacks a positive  
2 threshold voltage implant.

1 7. The self-starting reference circuit of claim 1 further comprises a second low-threshold n-  
2 channel FET having a gate, a source and a drain, its drain connected to the drain of the first p-  
3 channel transistor and to its own gate, its gate connected to the gate of the first low-threshold  
4 FET, and its source connected to the reference regulator circuit;

5 said reference regulator circuit comprises a bipolar junction transistor (BJT) having an  
6 emitter, a base and a collector, the emitter being coupled to the source of the second low-  
7 threshold n-channel FET and the collector and base being coupled to a ground; and

8 said reference output circuit comprising a resistance coupled between the source of the  
9 low-threshold transistor and ground.

1 8. The self-starting reference circuit of claim 6 wherein the circuit is implemented in Bi-CMOS.

1 9. The self-starting reference circuit of claim 1 wherein

2 said reference regulator circuit comprises a positive threshold voltage n-channel FET  
3 having a gate, source and drain, the drain connected to the drain of the first p-channel transistor,  
4 its gate connected to the source of the low-threshold FET, and its source being coupled to a  
5 ground; and

6 said reference output circuit comprising a resistance coupled between the source of the  
7 low-threshold transistor and ground.

1 10. In a self-starting reference circuit for providing a reference electrical characteristic

2 comprising a current mirror including a first p-channel field effect transistor (FET) and a second

3 p-channel FET configured to supply a reference current across the first FET and a mirrored  
4 output current across the second FET, each p-channel FET having a gate, a source and a drain  
5 wherein the gates of these FETs are connected, the sources are connected to a power supply, and  
6 the drain of the second FET is connected to the gates of these FETs, and a current source  
7 including a low-threshold n-channel FET having a source, a gate and a drain, the gate of the low-  
8 threshold FET being connected to the drain of the first p-channel FET and the drain of the low-  
9 threshold n-channel FET being connected to the drain of the second p-channel FET, the current  
10 source further including a reference regulator circuit for receiving the reference current from the  
11 drain of the first p-channel transistor and a reference output circuit for receiving the mirrored  
12 output current flowing from the source of the low-threshold n-channel FET and outputting a  
13 reference electrical characteristic, a method for operating a self-starting reference circuit  
14 comprising:  
15       the low-threshold FET generating a current across its transistor;  
16       generating a voltage across the reference output circuit based on the current;  
17       generating a voltage across the reference regulator based on the voltage across the  
18 reference output circuit; and  
19       providing a differential voltage between the power supply and the gates of the p-channel  
20 transistors causing forward active operation of the p-channel transistors.